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THE TECHNICAL COMMUNICATIONS PRACTICES OF ENGINEERING TECHNOLOGY STUDENTS: RESULTS OF THE NASA/DoD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT— THE PHASE 3 STUDENT SURVEYS

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Abstract

Engineering technology programs are characterized by their focus on application and practice, and by their approximately 50/50 mix of theory and laboratory experience. Engineering technology graduates are employed across the technological spectrum and are often found in areas that deal with application, implementation, and production. Yet we know very little about the communications practices and information-use skills of engineering technology students. In this paper, we report selected results of an exploratory study of engineering technology students enrolled in three U.S. institutions of higher education. Data are presented for the following topics: career goals and aspirations; the importance of, receipt of, and helpfulness of communications and information-use skills instruction; collaborative writing; use of libraries; and the use of electronic (computer) networks.

Introduction

The American Society of Engineering Education's Engineering Technology Council defines engineering technology as a profession in which a knowledge of mathematics and natural sciences gained by higher education, experience, and practice is devoted primarily to the implementation and extension of existing technology for the benefit of humanity. Engineering technology education focuses primarily on the applied aspects of science and engineering aimed at preparing graduates for practice in that portion of the technological spectrum closest to the product improvement, manufacturing and engineering operational functions. In 1992, there were 315 TAC/ABET-accredited BS/BET programs in over 90 disciplines in about 110 colleges and universities. The most popular program is electrical/electronics, followed by mechanical/manufacturing and civil engineering technologies. These three categories account for 85% of the graduates nationally (Cheshier, 1992).

Engineering technologists comprise a very important segment of the nation's technology workforce, yet we know little about them in terms of their communications practices and information-use behaviors. We know that information is an essential ingredient of research and development. Information is also central to the process of technological innovation. We also know that the ability of engineers and scientists to identify, acquire, and utilize information is positively correlated with technical performance at both the individual and group levels. Does the same hold true for engineering technologists? Studies, such as those by Mailloux (1989), demonstrate that the effective communication of information takes up as much as 80% of an engineer's time and is essential to successful engineering practice. Can a similar claim be made for engineering technologies? In the absence of data to the contrary, we take the position that the effective communication of information is essential to the professional success of engineering technologists.

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Because of the importance of the effective communication of information to engineering technology, questions arise regarding what communications skills should be taught to engineering technology students, when and how much communications instruction is necessary, and how effective that instruction is. In terms of competencies, employer and alumni feedback ranks communications skills low in the ability of entry-level engineering graduates to effectively write, make oral presentations, and search out and acquire information (Bakos, 1986; Chisman, 1987; Katz, 1993; Kimel and Monsees, 1979). But this same feedback ranks communications skills high in terms of their importance to engineering practice. Given the relationship between engineering and engineering technology and the similarities in the educational processes of engineering and engineering technology students, we speculate that employer and alumni feedback would rank the importance of communications skills **high** in terms of their importance to the professional success of engineering technologists but **low** in terms of the ability of entry-level engineering technologists to effectively write, make oral presentations, and search out and acquire information.

What is missing from any discussion of communications skills instruction for engineering technology students are (1) a clear explanation from the professional engineering technology community about what constitutes "acceptable and desirable communications norms" within that community, (2) adequate and generalizable data from engineering technology students about the communications skills instruction they receive, (3) adequate and generalizable data from entry-level engineering technologists about the adequacy and usefulness of the instruction they received as students, and (4) a mechanism, probably focused within academia, that solicits feedback from the workplace and a system that utilizes the feedback for answering the questions of what and how much should be taught and when and for determining the effectiveness of instruction.

To address the second question and help provide a student perspective, we undertook an exploratory study of engineering technology students enrolled in three U.S. institutions of higher education in October 1995. In this paper we present selected findings from the study that included questions about their career goals and aspirations; the importance of, receipt of, and helpfulness of communications and information-use skills instruction; collaborative writing; use of libraries; and the use and importance of electronic (computer) networks. The results of this study contribute to our understanding of the production and use of information by engineering technology students and provides feedback that may be helpful in shaping the communications components of engineering technology curricula.

Background

As a Phase 3 activity of the NASA/DoD Aerospace Knowledge Diffusion Research Project, we surveyed engineering technology students at Brigham Young University (BYU), Embry-Riddle (E-R) Aeronautical University, and North Dakota State University (NDSU) in October 1995. Specifically, we examined (1) their career choice, including the factors leading to that choice, career choice satisfaction, and career-related goals and aspirations, and (2) their communications practices and information behaviors, including the instruction they receive as part of their undergraduate engineering technology education, their collaborative writing practices, their use of libraries, and their use of computer (electronic) networks.

The NASA/DoD Aerospace Knowledge Diffusion Research Project was undertaken to gain a better understanding of the methods that aerospace engineers and scientists use to acquire, use, produce, and communicate information. The position of the United States (U.S.) as a world leader in aerospace depends in large part on maintaining and improving the competence of aerospace engineers and scientists. The ability of U.S. aerospace engineers and scientists to acquire and utilize the results of the latest aerospace research and development findings is a major factor in enhancing innovation and productivity within that industry (Pinelli, Kennedy, and Barclay, 1991). The Project was conducted in four phases. Phase 1 focuses on the information-seeking practices of U.S. aerospace engineers and scientists. Phase 2, which surveyed aerospace librarians in government and industry, explores how federally funded research and development results are distributed. Phase 3 examines the transfer of aerospace research and development knowledge within the academic sector. Phase 4 explores the information-seeking behaviors of aerospace engineers and scientists outside the U.S.

Related Literature

We have limited our review to literature that focuses on engineering communications and the composing and writing practices of engineers. The composing and writing practices of individual engineers were studied by Selzer (1983) and Winsor (1990, 1992). Davis (1977) and Spretnak (1982) surveyed engineering professionals to determine the impact and importance of

effective communications skills on career success and advancement and the value of technical communications training. Middendorf (1980) examined the academic subjects most needed for success in the workplace and proposed a competency inventory for engineering students that prioritized information retrieval and dissemination skills. David (1982) surveyed recent engineering and science graduates to determine the importance of writing proficiency to job performance. In an exploration of specific writing skills and applications, Goubil-Gambrell (1992) studied recent electrical and computer engineering graduates to determine the types of communications they produce in entry-level positions; Strother (1992) surveyed electrical, mechanical, and civil engineering seniors to determine their expectations of the importance and types of writing they anticipate doing in the workplace.

Paradis, Dobrin, and Miller (1985) note that college training itself does not prepare engineering graduates to communicate successfully in the work environment because core engineering and science curricula seldom include writing and editing; when the core curricula do, instructors of engineering or science writing usually know little about the actual environments in which students will work. Paradis, Dobrin, and Miller suggest that the writing skills of engineering students be improved by modifying the curricula in schools of engineering based on the results of studies of communication in the workplace. Tebeaux (1985) concluded from a review of the literature that many academic writing courses that purportedly focus on pragmatic writing (i.e., writing for business and industry) still teach writing that bears little resemblance to on-the-job communications. Schreiber (1993) analyzed the differing discourse communities of academic writing and technical communication. The literature suggests, based on feedback from professional engineers about the communications abilities of new engineering graduates, that (1) a disconnect may exist between the academic preparation of engineers and the world of work that they enter upon graduation, and (2) many academicians agree that college training may not prepare engineering graduates to communicate successfully in the workplace. They suggest that the curricula in schools of engineering could benefit from modifications based on studies of communication in the workplace.

Methods

Self-administered (self-reported) questionnaires were sent to colleagues at the three institutions. They, in turn, distributed the questionnaires to engineering technology students via their departmental mail boxes. A single (no follow-up) distribution was used at all three institutions. The exact number of surveys distributed at each institution is not known. We received 26 completed surveys from Brigham Young University (BYU), 50 from Embry-Riddle (E-R) Aeronautical University, and 21 from North Dakota State University (NDSU).

Sample Demographics

Survey respondents were predominately male (BYU/100%, E-R/89%, and NDSU/95%). About 54% of the BYU students were undergraduates, almost 94% of the E-R students were undergraduates, and 100% of the NDSU students were undergraduates. About 75% of the BYU students were manufacturing (engineering) technology majors, almost 98% of the E-R students were aircraft or avionics (engineering) technology majors, and about 95% of the NDSU students were aero-manufacturing (engineering) technology majors. Most of the students are United States natives (BYU/91.7%, E-R/75.6%, and NDSU/90.5%), and about equal numbers speak English as their native language (BYU/91.7%, E-R/75.6%, and NDSU/95.2%).

Career Information

Students were asked to compare their families' incomes to incomes of other families in their native country. Most students reported that their family incomes were equal to or greater than the incomes of other families. Students were also asked to indicate at what point they had made their career choice (i.e., decision to become an engineering technologist). About 46% of the BYU students made their decision after they started college, almost 48% of the E-R students made their decision while they were in high school, and about 43% of the NDSU students made their decision after they started college. Students were also asked to rate their current level of satisfaction with their career choice. About 54% of the BYU students indicated that they were happier now with their career choice than when they first made it. Fifty-one percent of the E-R students reported that they feel about the same now as when they first made their career choice. The NDSU students were about evenly split in their responses; 47.6% indicated that they were happier now with their career choice than when they first made it and 47.6% indicated that they feel about the same now as when they first made they career choice.

Student participants were asked to rate the importance of 15 goals for a successful career. The list includes aspirations that are classified as engineering, science, or management goals. Importance was

measured on a 7-point scale with 7 being the highest possible importance. The engineering goal, "having the opportunity to explore new technology or systems," received the highest mean rating ($\overline{X}$ = 6.1) from the BYU students. Overall, the BYU students rated the management goals highest and most important in terms of a successful career. The E-R students identified the engineering goal, "having the opportunity to explore new technology or systems," highest ($\overline{X}$ = 6.3). Overall, the E-R students rated the engineering goals highest and most important in terms of a successful career. The management goal, "become a manager or director," received the highest mean rating ($\overline{X}$ = 6.0) from the NDSU students. Overall, the NDSU students rated the engineering goals highest and most important in terms of a successful career.

Data

The literature on engineering education establishes the importance of effective communications and information-use skills to professional success (Black, 1994; Morrow, 1994; Evans, et. al., 1993; Katz, 1993; Garry, 1986; Devon, 1985). Student respondents from the three institutions were asked to assess the importance of selected communications and information-use skills to professional success, to indicate if they had received instruction in these skills, and to rate the helpfulness (usefulness) of that instruction.

Importance of Communications and Information-Use Skills to Professional Success

Students were asked to rate the importance of six communications and information-use skills to professional career success (Table 1). Overall, the BYU students assigned high importance ratings to the six communications and information-use skills. They assigned the highest importance rating to "the ability to use computer, communication and information technology" ($\overline{X}$ = 6.4). Oral and written technical communications skills received the next highest importance ratings. The mean importance ratings for these skills were about 6.25. The ability to search electronic (bibliographic) databases received the lowest importance rating ($\overline{X}$ = 5.5) from the BYU students.

Of the three groups of respondents, the E-R students assigned the highest overall importance ratings to the six communications and information-use skills. They assigned the highest importance rating to "the ability to use computer, communication and information technology" ($\overline{X}$ = 6.5) followed by "knowing how to use a library that contains engineering/science resources" ($\overline{X}$ = 6.2). Oral and written technical communications skills received the next highest importance ratings ($\overline{X}$ = 6.1). The ability to search electronic (bibliographic) databases received the lowest importance rating ($\overline{X}$ = 5.8) from the E-R students.

Table 1. Importance of Communications and Information-Use Skills to Professional Success

	BYU		E-R		NDSU	
Skills	Mean[a]	(n)	Mean[a]	(n)	Mean[a]	(n)
Effectively communicate technical information in writing	6.2	(26)	6.1	(50)	5.8	(21)
Effectively communicate technical information orally	6.3	(26)	6.1	(50)	5.9	(21)
Have a knowledge and understanding of engineering/ science resources and materials	6.0	(26)	6.4	(50)	5.9	(21)
Be able to search electronic (bibliographic) databases	5.5	(26)	5.8	(49)	5.6	(21)
Know how to use a library that contains engineering/ science resources and materials	5.7	(26)	6.2	(50)	5.4	(21)
Effectively use computer, communication, and information technology	6.4	(26)	6.5	(50)	5.9	(21)

[a]Students used a 7-point scale to rate importance, where 7 indicates the highest rating.

The NDSU students assigned the high importance ratings ($\overline{X}$ = 5.9) to "the ability to use computer, communication and information technology," "the ability to effectively communicate technical information orally," and "having a knowledge and understanding of engineering/science resources and materials." "Knowing how to use a library that contains engineering/science resources and materials" received the lowest importance rating ($\overline{X}$ = 5.4) from the NDSU students.

Receipt of Communications and Information-Use Skills Instruction

Table 2 shows the percentages of students from the three institutions who have received communications and information-use skills instruction. High percentages of the respondents from each of the three institutions reported having received communications

Table 2. Receipt of Communications and Information-Use Skills Instruction

Skills	BYU %	BYU (n)	E-R %	E-R (n)	NDSU %	NDSU (n)
Technical writing/ communication	88.5	(23)	100.0	(50)	81.0	(17)
Speech/oral communication	73.1	(19)	90.0	(45)	85.7	(18)
Using engineering/ science information resources and materials	80.8	(21)	86.0	(43)	85.7	(18)
Searching electronic (bibliographic) databases	69.2	(18)	72.0	(36)	71.4	(15)
Using a library con - taining engineering/ science information resources and materials	84.6	(22)	86.0	(43)	90.5	(19)
Using computer, communication, and information technology	76.9	(20)	82.0	(41)	100.0	(21)

and information-use skills instruction as part of their engineering technology education. About 89% of the BYU students have received technical writing instruction, followed by instruction in using a library containing engineering/science information resources (84.6%), skill in using engineering/science information resources and materials (80.8%), and skill instruction in the use of computer, communication, and information technology (76.9%).

One hundred percent of the E-R students have received technical writing instruction, followed by instruction in oral communications (90%), instruction in using a library containing engineering/science information resources and materials (86%), and skill in using engineering/science information resources and materials (86%). About 84% of the E-R respondents, reported having received skill instruction in the use of computer, communication, and information technology (82%).

All of the NDSU respondents reported having received skill instruction in the use of computer, communication, and information technology. About 91% of the NDSU students have received skill instruction in using a library containing engineering/science information resources and materials. At least 80% of the NDSU respondents have received skill instruction in oral communications, using engineering/science information resources and materials, and technical writing instruction.

Table 3. Helpfulness of Communications and Information-Use Skills Instruction[a]

Skills	BYU Mean[b]	BYU (n)	E-R Mean[b]	E-R (n)	NDSU Mean[b]	NDSU (n)
Technical writing/ communication	6.0	(23)	5.8	(50)	5.6	(16)
Speech/oral communication	5.7	(19)	5.6	(45)	5.8	(18)
Using engineering/ science informa- tion resources and materials	5.3	(21)	5.2	(43)	5.6	(18)
Searching electronic (bibliographic) databases	5.1	(18)	5.3	(36)	5.5	(15)
Using a library con - taining engineering/ science information resources and materials	5.4	(21)	5.3	(43)	5.3	(19)
Using computer, communication, and information technology	5.9	(20)	5.9	(41)	6.2	(21)

[a]Includes ratings only for those students who received training/ instruction in each communications/information-use skill.

[b]Helpfulness was rated using a 7-point scale, where 7 indicates the highest rating.

Helpfulness of Communications and Information-Use Skills Instruction

Students who had received communications and information-use skill instruction were asked to rate the helpfulness (usefulness) of that instruction (Table 3). Helpfulness was rated on a 7-point scale with 7 being the highest rating. Overall, student respondents from all three schools reported that the instruction they had received was helpful. The BYU students assigned the highest ratings to instruction in technical writing/communication ($\bar{X}$ = 6.0) and using computer, communication, and information technology ($\bar{X}$ = 5.9). E-R students assigned the highest ratings to instruction in using computer, communication, and information technology ($\bar{X}$ = 5.9) and technical writing/ communication ($\bar{X}$ = 5.8). The NDSU students assigned the highest ratings to instruction in using computer, communication, and information technology ($\bar{X}$ = 6.2) and speech/oral communication ($\bar{X}$ = 5.8).

Impediments to Preparing Written Technical Communications

We asked students to report the extent to which a lack of knowledge/skill about certain communications principles impedes their ability to produce written

Table 4. Impediments to the Production of Written Technical Communications

Principles	BYU Mean[a]	BYU (n)	E-R Mean[a]	E-R (n)	NDSU Mean[a]	NDSU (n)
Defining the purpose of the communication	4.6	(23)	4.3	(50)	3.2	(20)
Assessing the needs of the reader	4.6	(24)	4.3	(50)	3.6	(19)
Preparing/presenting information in an organized manner	4.5	(24)	4.1	(49)	3.2	(20)
Developing paragraphs (introductions, transitions, conclusions)	4.3	(23)	4.1	(50)	3.2	(20)
Writing grammatically correct sentences	3.9	(24)	4.1	(47)	3.2	(20)
Notetaking and quoting	4.0	(24)	3.7	(48)	3.0	(20)
Editing and revising	3.9	(23)	3.9	(46)	2.7	(20)

[a]The extent to which each principle impedes was measured using a 7-point scale, where 7 indicates the highest rating.

technical communications (Table 4). The extent to which the lack of knowledge/skill about a certain communications principle impeded their ability was measured using a 7-point scale with 7 being the highest rating. Overall, students did not report serious problems with their writing skills, at least to the point that any deficiencies might impede the technical writing process. Furthermore, there were small differences between students from the three instructions in the assessments of their writing skills.

Students appear to have the least difficulty with those writing skills that most students have the opportunity to use frequently. Grammar skills, notetaking and quoting, and skills related to editing and revising received the lowest "impedance" scores. Skill areas where the students report the most difficulty are in assessing the needs of the reader and presenting information in an organized manner. The highest mean difficulty scores for the BYU, E-R, and NDSU students were for "defining the purpose of the communication," "assessing the needs of the reader," and preparing/presenting information in an organized manner."

Collaborative Writing

Most of the students we surveyed appear to have little experience in writing collaboratively. Over 65% of BYU students, about 60% of the E-R students, and about 43% of the NDSU students reported that they do not produce written technical information as part of a group (Table 5). Higher percentages of these students reported that writing performed as part of their academic preparation is required to be collaborative. We also asked students who write collaboratively to compare the productivity of group writing to the productivity of writing alone. A high percentage of students reported that group writing is more productive than writing alone (Table 6). Forty-five percent of the BYU students and nearly 45% of the E-R students reported that writing in a group is more productive than writing alone. Fifty percent of the NDSU students reported that writing in a group is more productive than writing alone. Thirty-five percent of the BYU students, about 40% of the E-R students, and about 13% of the NDSU students reported that group writing is less productive than writing alone.

Table 5. Percentage of Student Writing That Is Collaborative

Group Writing	BYU $\bar{X}$[a]%	BYU (n)	E-R $\bar{X}$[a]%	E-R (n)	NDSU $\bar{X}$[a]%	NDSU (n)
Writing done in groups	36.3	(20)	38.9	(36)	46.8	(16)
Writing required to be collaborative	46.1	(19)	54.3	(33)	62.2	(16)

[a]The means exclude students who report that they never collaborate on academic writing projects.

Table 6. Productivity of Collaborative Writing

Productivity	BYU %	BYU (n)	E-R %	E-R (n)	NDSU %	NDSU (n)
More productive than writing alone	45.0	(9)	44.7	(17)	50.0	(8)
About the same as writing alone	20.0	(4)	15.8	(6)	37.5	(6)
Less productive than writing alone	35.0	(7)	39.5	(15)	12.5	(2)

[a]Percentages exclude students who report that they never collaborate on academic writing projects.

Library Use Instruction

We asked students to indicate if they had received instruction in six areas related to library use (Table 7). At least 50% of the BYU students had received instruction in each of the six areas. About 94% of the E-R students had received a tour of the library and about 82% of them had received a presentation about the library as part of their academic orientation. About two-thirds of the NDSU students had received a tour of the library, a presentation about the library as part of their academic orientation, and a library skill/use course (bibliographic instruction).

Table 7. Receipt of Library Instruction

	BYU		E-R		NDSU	
Type of Instruction	%	(n)	%	(n)	%	(n)
Library tour	60.0	(15)	93.5	(43)	61.9	(13)
Library presentation as part of academic orientation	60.0	(15)	82.2	(37)	66.7	(14)
Library orientation as part of an engineering/sciene course	56.0	(14)	40.5	(17)	42.1	(8)
Library skill/use course (bibliographic instruction)	44.0	(11)	64.4	(29)	61.9	(13)
Library skill/use course in engineering/sciene information resources and materials	52.0	(13)	38.1	(16)	33.3	(6)
Library instruction for end-user searching of electronic (bibliographic) databases	62.5	(15)	64.4	(29)	52.9	(9)

*Percentages include only those students who reported that the instruction was available.

Finally, we asked survey respondents a series of questions concerning general information use. The BYU students reported having received about 9 hours of instruction in using engineering/science information resources, electronic (bibliographic) databases, and electronic (computer) networks for information retrieval. E-R students reported having received about 12 hours of instruction in using engineering/science information resources, electronic (bibliographic) databases, and electronic (computer) networks for information retrieval. Students from NDSU reported having received about 13 hours of instruction in using engineering/science information resources, electronic (bibliographic) databases, and electronic (computer) networks for information retrieval.

Library Use

Library use among the E-R students was almost double that of the BYU students and almost triple that of the NDSU students (Table 8). The average number of uses for the BYU students was 8.9 (median = 0.0). E-R students recorded an average of 17.2 uses in the past school term (median = 10.0). Students at NDSU reported an average of 6.6 visits to the library in the past school term (median = 5.0). Finally, we asked

Table 8. Use of a Library This Past School Term

	BYU		E-R		NDSU	
Number of Visits	%	(n)	%	(n)	%	(n)
0	52.0	(13)	2.2	(1)	10.0	(2)
1-5	20.0	(5)	35.6	(16)	45.0	(9)
6-10	12.0	(3)	17.8	(8)	40.0	(8)
11-25	8.0	(2)	26.7	(12)	5.0	(1)
26-50	4.0	(1)	11.1	(5)	0.0	(0)
51 or more	4.0	(1)	6.7	(3)	0.0	(0)
Mean	8.9	(25)	17.2	(45)	6.6	(20)
Median	0.0	—	10.0	—	5.0	—

Table 9. Effectiveness of Information Obtained From the Library in Meeting Engineering/Science Information Needs

	BYU		E-R		NDSU	
Effectiveness	%	(n)	%	(n)	%	(n)
Very effective	36.4	(4)	59.6	(28)	36.8	(7)
Neither effective nor ineffective	63.6	(7)	36.1	(19)	57.3	(11)
Very ineffective	0.0	(0)	4.3	(2)	5.3	(1)

survey respondents how many hours each week they spent reading (i.e., keeping up with) the professional literature in their discipline. E-R students reported spending an average of 6.2 hours weekly reading the professional literature. NDSU student respondents reported spending an average of 3.9 hours each week and BYU students reported spending an average of 1.5 hours each week reading the professional literature.

Effectiveness of Information Obtained from the Library

Students who had used the library during the past school term were asked to rate the effectiveness of the information they obtained from the library in meeting their engineering/science information needs (Table 9). About 35% of the BYU students reported that the information they received from the library was very effective. Almost 60% of the E-R students indicated that the information they obtained from the library was very effective in meeting their engineering/science information needs. Almost 37% of the NDSU students indicated that the information they obtained from the library was effective.

Searching of Electronic (Bibliographic) Databases

We were also interested in finding out how students search electronic (bibliographic) databases (Table 10). About 63% of the BYU students, almost 64% of the E-R students, and about 53% of the NDSU students received library instruction for end-user searching of

Table 10. Searching Electronic (Bibliographic) Databases

Approach	BYU %	BYU (n)	E-R %	E-R (n)	NDSU %	NDSU (n)
I do all searches myself	37.5	(9)	20.4	(10)	33.3	(7)
I do most searches myself	33.3	(8)	40.8	(20)	52.4	(11)
I do half by myself and half through a librarian	12.5	(3)	14.3	(7)	0.0	(0)
I do most searches through a librarian	4.2	(1)	14.3	(7)	4.8	(1)
I do all searches through a librarian	0.0	(0)	0.0	(0)	4.8	(1)
I do not use electronic databases	8.3	(2)	10.2	(5)	4.8	(1)
I do not have access to electronic databases	4.2	(1)	0.0	(0)	0.0	(0)

Table 11. Use of Electronic (Computer) Networks

Factor	BYU %	BYU (n)	E-R %	E-R (n)	NDSU %	NDSU (n)
Yes, I personally use them	57.7	(15)	70.0	(35)	66.7	(14)
Yes, I use them but through an intermediary	19.2	(5)	10.0	(5)	14.3	(3)
No	7.7	(2)	4.0	(2)	4.8	(1)
No, because I do not have access to electronic networks	15.4	(4)	0.0	(0)	0.0	(0)
No, but I may use them in the future	0.0	(0)	16.0	(8)	14.3	(3)

electronic (bibliographic) databases. Therefore, we conclude that students appear to be fairly well trained in conducting these searches. Almost all of the students we surveyed reported having access to electronic (bibliographic) databases. About 71% of BYU students, about 61% of the E-R students, and about 86% of the NDSU students reported that they do all or most of their searches themselves. Only about 17% of the BYU students, about 29% of E-R students, and about 10% of the NDSU students obtain help from a librarian in conducting searches of electronic bibliographic data bases. About 8% of the BYU students, almost 10% of the E-R students, and about 5% of the NDSU students do not use electronic (bibliographic) databases.

Use of Electronic (Computer) Networks

Nearly 85% the BYU students we surveyed reported having access to electronic (computer) networks. One hundred percent of the E-R and NDSU students indicated that they had access to electronic (computer) networks. Most of the students indicated that they personally use (as opposed to using them through an intermediary) electronic (computer) networks (see Table 11). Students use networks for a variety of purposes (see Table 12). Ninety percent of the BYU students and about 84% of E-R students use electronic (computer) networks for exchanging electronic mail. About 94% of the NDSU students use electronic (computer) networks to connect to graphically distant sites.

Table 12. Use of Electronic (Computer) Networks for Specific Purposes

Purpose	BYU %	BYU (n)	E-R %	E-R (n)	NDSU %	NDSU (n)
To connect to geographically distant sites	50.0	(10)	67.6	(25)	93.8	(15)
For electronic mail	90.0	(18)	84.2	(32)	76.5	(13)
For electronic bulletin boards or conferences	45.0	(9)	52.6	(20)	68.8	(11)
To access/search the library's catalogue	85.0	(17)	78.9	(30)	76.5	(13)
To order documents from the library	15.0	(3)	32.4	(12)	6.7	(1)
To search electronic (bibliographic) databases	55.0	(11)	70.3	(26)	50.0	(8)
To prepare scientific and technical papers with colleagues at geographically distant sites	15.8	(3)	22.2	(8)	18.8	(3)
For information search and data retrieval with the following:						
FTP	44.4	(8)	42.4	(14)	40.0	(6)
Gopher	29.4	(5)	44.4	(16)	66.7	(10)
WAIS	5.9	(1)	12.1	(4)	7.1	(1)
World Wide Web (WWW)	52.6	(10)	66.7	(24)	66.7	(10)

We also asked students about their use of electronic (computer) networks for information search and data retrieval with the following: FTP, Gopher, WAIS, and the WWW. Slightly more than 50% of the BYU students reported use of the WWW; about 44% reported use of FTP. Similarly, about 67% of the E-R students reported using the WWW and about 44%/43% used Gopher and FTP. About 67% of the NDSU students indicated that they used the WWW and Gopher for information search and data retrieval.

Table 13. Use of Electronic (Computer) Networks to Exchange Messages or Files

	BYU		E-R		NDSU	
Exchange With—	%	(n)	%	(n)	%	(n)
Members of your academic classes	80.0	(16)	79.5	(31)	70.6	(12)
Other people in your academic community at the SAME geographic site who are not in your academic classes	40.0	(8)	59.0	(23)	35.3	(6)
Other people in your academic community at a DIFFERENT geographic site who are not in your academic classes	20.0	(4)	41.0	(16)	52.9	(9)
People outside of your academic community	65.0	(13)	59.0	(23)	70.6	(12)

Students who use networks to exchange messages or files do so with others at a variety of locations. Eighty percent of the BYU students, about 80% of the E-R students, and about 71% of the NDSU students exchange messages or files with members of their academic classes (see Table 13). Sixty five percent of the BYU students, 59% of the E-R students, and about 71% of the students at NDSU exchange messages or files with people outside of their academic community.

Findings

Given the exploratory nature of this study, the overall sample size, and the research design, no claims are made regarding the extent to which the attributes of the respondents in the three surveys accurately reflect the attributes of the populations being studied. A much more rigorous design and a larger sample would be needed before any such claims could be made. Nevertheless, the findings do permit the formulation of the following general statements regarding the technical communications practices and information behaviors of the engineering technology students from BYU, E-R, and NDSU who participated in this study.

1. In terms of making a career decision to become an engineering technologist, the BYU students made their decision after they started college, the E-R students made their decision while they were in high school, and the NDSU students made their decision after they started college.
2. The BYU students rated the management goals highest and most important in terms of a successful career. The E-R and the NDSU students rated the engineering goals highest and most important in terms of a successful career.
3. A majority of students surveyed expressed the opinion that a mastery of communications and information-use skills is important to their professional success as an engineering technologist.
4. A majority of the students surveyed reported that they had received communications and information-use skills instruction/training. Students who had received the instruction/training indicated that it was helpful (useful).
5. Overall, students did not report serious problems with their writing skills, at least to the point that any deficiencies might impede the technical writing process. Furthermore, there were small differences among students from the three institutions and their assessments of their writing skills. Students reported "defining the purpose of the communication," "assessing the needs of the reader," and preparing/presenting information in an organized manner" as the greatest impediments to preparing written technical communications.
6. Most of the students surveyed reported that the writing associated with their academic preparation is performed alone (i.e., not in groups). Slightly more than half of the E-R and about 62% of the NDSU students reported that some of their academic writing is required to be collaborative.
7. Most of the students surveyed have received some form of library instruction during the course of their academic preparation.
8. Most of the students surveyed had access to electronic (bibliographic) databases, used them, and did all or most of their searches (of bibliographic databases) themselves.
9. The students we surveyed reported having access to electronic (computer) networks. Most of the students indicated that they personally use (as opposed to using them through an intermediary) electronic (computer) networks.
10. The students we surveyed made considerable use of FTP, Gopher, WAIS, and the WWW for information search and data retrieval.

Concluding Remarks

We stated earlier that four elements are missing from current discussions of communications and

information-use skills and competencies for engineering technology students: (1) a clear explanation from the professional engineering community about what constitutes "acceptable and desirable communications norms" within that community; (2) adequate and generalizable data from engineering technology students about the communications and information-use skills instruction they receive; (3) adequate and generalizable data from entry-level engineering technologists about the adequacy and usefulness of the instruction they received as students; and (4) a higher-level theoretical framework, a comprehensive understanding of the nature of knowledge and learning, within which the interpretation of such data can take on consistent and fuller meaning.

Although the findings of our study have provided some insights about the communications and information-use skills instruction of engineering technology students, we have raised more questions than we have answered. We suggest the following. Conduct a series of coordinated studies designed to obtain adequate and generalizable data about the communications and information-use skills instruction that students in various engineering technology disciplines receive as part of their academic preparation. Undertake a study of entry-level engineering technologists across engineering technology disciplines to determine what kinds of communications they produce and what communications and information-use skills they use to produce them. Collect adequate and generalizable data from entry-level engineering technologists across engineering technology disciplines about the adequacy and usefulness of the communications and information-use skills instruction they received as students. Finally, determine from among the professional engineering technology community what constitutes acceptable and desirable communications norms in light of the possibility that entry-level engineering technologists may lack the communications and information-use skills needed for professional success.

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